Guideline
Mechanical and Process Isolations
Major Hazard Standard

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1 PURPOSE AND SCOPE

This document provides isolation strategies and standards for establishing effective isolation of process and mechanical systems and shall be used to develop Isolation Certificates for application within the Permit to Work System.

This document should be read in conjunction with Major Hazard Standard 07 Permit to Work.

This document deals primarily with mechanical and process isolations for intrusive work and not electrical isolations.

2 DEFINITIONS

Term	Definition
Blank Flange	A component for closing an open end of pipe-work which is rated to the same standard as the flange to which it is fitted
Bleed, Drain or Vent Valve	A valve for draining liquids, venting gas or monitoring pressure for confirmation of isolation valve integrity
Block Valve	A valve which provides a tight shut-off for isolation purposes
Double Block and Bleed	An isolation method consisting of an arrangement of two block valves with a bleed valve located in between the two block valves
Isolation	The separation of plant from every source of energy in such a way that separation is secure
Isolation Scheme	A system incorporating three key components – management arrangements, risk control procedures and working level practices, to ensure hazardous substances are not released nor people or the environment exposed to risks during the maintenance or repair of plant and equipment
QRA	Quantitative Risk Assessment
Slip-ring	A spacer ring installed in pipe-work to facilitate the insertion of a spade
Spade (slip-plate)	A solid plate made of the same material and rating as the flange, for insertion into pipe-work to secure isolation
Spectacle Blind	A combined spade and slip ring in figure 8 shape rated to match flange fittings
Long Term Isolation	An isolation that remains in place after Work Permit cancellation

3 REFERENCES

- Oil Industry Advisory Committee, The Safe Isolation of Plant and Equipment
- MHS 07, Permit to Work Standard

4 DETAILS

4.1 Overview

All isolation activities shall be carried out as part of the Permit to Work System. This System specifies the control processes and the authorised personnel responsible for defining, implementing and checking of a safe and effective Isolation Scheme.

An Isolation Scheme shall be defined on an Isolation Certificate. The scheme shall be based upon risk assessment with the objective being to secure plant and equipment so that the risk of an uncontrolled release of energy to atmosphere with consequent injury to personnel or damage to plant / equipment or the environment is reduced to as low as is reasonably practicable.

There may be times when the desired standard of isolation cannot be achieved (eg insufficient isolation points, or the isolation points available do not provide effective isolation) and a lower level of integrity has to be accepted. All instances of this shall be appropriately analysed by a further risk assessment and authorised by the Area Production Superintendent or delegate prior to a Work Permit being issued. In all situations the final set of hazard controls implemented prior to commencing work shall provide an acceptable level of safety for people, plant and the environment. To satisfy long term improvement to the site isolation facilities, an Engineering Change proposal should be raised for upgrade of isolation equipment.

4.2 General

Mechanical isolation is the prevention of movement between equipment parts in the work area. This requires the application of some or all of the following provisions:

- Positive isolation of the moving parts from all sources of hydraulic fluid
- Positive isolation from any process or utility (air or other) drive source
- Disconnection of mechanical couplings and drive shafts
- The fitting of physical stops between moving parts to prevent inadvertent movement.

Process isolation refers to the isolation of various process substances (solids, liquids and gases) to allow intrusive work, confined space entry and various other works. Wherever practicable, work should be carried out on units or systems that have been totally shutdown, isolated, depressurised, drained and freed from flammable, corrosive, asphyxiant and toxic material. Where possible, conveyor belts, hoppers or solid feed systems should be emptied.

The primary objective is to use the highest level of isolation integrity which is reasonably practicable.

The adequacy of isolations should reflect the reasonably foreseeable risk and the consequences should that risk be realised.

If it can be shown that the cost of adopting a more secure method of isolation is not disproportionate to the benefit, in terms of risk reduction, the more secure isolation method should be used.

Where it is determined during the risk assessment process that the exposure to hazards in achieving the required standard of isolation may be greater than the exposure to the hazards in carrying out the intrusive work ie. time, access and location of isolation points etc, the risk assessment process shall be used to determine a suitable alternative method.

Isolations shall be secure throughout the duration of the activity and be adequately tested to prove their effectiveness.

Plant and equipment shall be clearly identified. Isolation documentation shall be developed according to the Permit to Work requirements.

Personnel shall be proven competent in their knowledge and understanding of hazards, the plant and equipment and the skills necessary to effect, prove and remove isolations.

To allow for situations when a total process shutdown is not possible, the system design incorporates facilities to adequately isolate individual units or sub-systems from live plant in order to protect personnel and equipment.

The Permit Issuer shall assess the implications of any potential ignition source release from isolations with other work planned in the same vicinity.

When carrying out isolations the following general rules apply:

- The valves closest to the equipment should be used.
- Some process plant and equipment is potentially dangerous if valves that are part of the isolation scheme are not operated in the correct sequence. This sequence shall be defined in the Isolation Certificate.
- Do not block in Pressure Safety Valves until the equipment or vessel is depressurised and adequate vents are open to prevent over pressurising equipment.
- Ensure that no gas or liquid is trapped in sections that do not have pressure protection or thermal release. In certain circumstances pressure build up due to increase in ambient temperature can lead to catastrophic failure of equipment.

4.3 Risk Assessment

A risk assessment shall be used to develop Isolation Schemes. It should consider both the task of performing the isolation together with the task for which the isolation is required.

In determining the inherent risk to people, plant and the environment when carrying out the risk assessment, the following considerations should be made with regard to any of the properties of the primary or associated systems:

- Toxicity
- Flammability
- Effects of contact with skin
- Temperature
- Pressure
- Specific gravity (consider surroundings e.g. sumps and under flooring)
- Size of any potential leak of hazardous materials
- The natural ventilation of the surrounding area
- The likelihood of any pressurising of the line
- The risks and hazards involved in providing the isolations

Further assessment of the suitability and security of the isolation scheme shall take place where the isolations are to remain in place for an extended period of time (See Long Term Isolations Section 4.7).

Appendix A provides a tool to assist in the selection of the most appropriate isolation standard for a specific isolation. Appendix B provides information on different isolation devices that can be employed and Appendix C covers special precautions associated with making isolations.

4.4 Isolation Standards

There are three Isolation Standards:

- **Standard 1**: Single valve and bleed
- **Standard 2**: Double valve and bleed
- **Standard 3**: Physical disconnection or spool removal and fitting of blank flanges, or insertion of spades or spectacle blinds

4.4.1 Isolation Standard 1

This represents the lowest level of isolation and care shall be taken to ensure proof of an effective seal.

Single block valve isolation uses an adjacent drain valve to assist in detecting an ineffective seal.

It is applicable for:

- Hot, flashing non-flammable liquid (e.g. domestic hot water) at all pressures
- Non-flammable, non-flashing, non-toxic, non-irritant liquids (e.g. firewater, potable water, cooling water) at all pressures
- Non-flammable, non-toxic gases (e.g. plant air, instrument air, nitrogen gas) at <1000KPa.

4.4.2 Isolation Standard 2

The double valve and bleed valve arrangement consists of two separate block valves in a line, with a bleed valve in the connecting line between them. Ideally the two block valves are located relatively close together. The bleed is to be routed to a safe location but should be visible and accessible to confirm an effective isolation.

The bleed valve normally has two functions. Firstly to indicate if the upstream valve is passing. Secondly, in the event of the upstream valve passing, the bleed prevents pressuring the line between the block valves (in this circumstance the drain line must be directed to a safe location and monitored).

The following issues should be considered when using bleed valves:

- Possibility of bleed valve blockage
- Ensuring the process operator can detect flow through the bleed when checking integrity of isolating valves
- Ensuring that bleed valves are accessible
- Blind off bleeds where possible when they are closed during normal plant operations
- Diversion of any excess leakage to a safe location

- Cease work if the bleed is passing significant quantities as pressure may increase between the double block valves possibly causing the downstream block valve to leak.

This method of isolation shall be deemed invalid if the bleed section of the isolation cannot be fully depressurised to atmosphere. It is applicable for:

- Flammable, flashing liquids and flammable gases (not hydrogen) at all pressures
- Toxic gases or toxic liquids at all pressures
- Flammable liquids at all pressures
- Non-flammable, hot, flashing liquids at all pressures
- Non-flammable, non-toxic, non-irritant liquids at high pressures (e.g. process cooling water at >1700KPa and liquid nitrogen at all pressures)
- Non-flammable, non-flashing, non-toxic, non-irritant, asphyxiant gases (e.g. nitrogen gas, CO_2)
- Non-flammable, non-flashing, toxic and/or irritant liquids (e.g. treatment chemicals, hypochlorite, biocides, scale and corrosion inhibitors, demulsifiers) at all pressures.

4.4.3 Isolation Standard 3

This standard provides a positive and highest level of isolation. It provides a high integrity physical barrier between the hazard (energy) and the environment in which work is being done.

Physical disconnection should be achieved whenever it is reasonably practical to do so. It is easier to visually monitor a removed spool than to visually check if a spectacle blind has been installed. Similarly, a spectacle blind should be used in preference to a spade.

It is normally applicable for:

- Confined Space Entry
- Opening of equipment for maintenance while the remainder of the unit is in operational service and there is a consequent high level of risk of uncontrolled energy release
- Opening of equipment when the remainder of the unit, though not in operation, contains hazardous materials and there is a high level of risk of uncontrolled energy release
- Hydrostatic testing of equipment
- Hot work on pressurised hydrocarbon systems
- Long term isolations.

4.5 Isolation Methods

4.5.1 Implementing Isolation Standard 1

When isolating non hazardous systems establish the single valve isolation and conduct valve integrity test by checking for leakage.

When isolating a hazardous system (having considered this action as part of a rigorous risk assessment) the following requirements must be met:

- The fire and gas detection system in the area shall not be inhibited
- No hot work permits allowed within a minimum of a 15 meter radius of work

- On-going integrity of the sealing valve must be monitored
- The work site shall be monitored by a Process Technician.

4.5.2 Implementing Isolation Standard 2

Isolation Standard 2 requires bleed valves to be available to enable block valve integrity to be determined. The system inventory i.e. the live plant, is the normal medium used for testing valve integrity. Additionally nitrogen or water from an external source can be used.

In pressure systems that have liquid inventories only, use an open bleed valve to monitor for any visual leakage in the section of piping between the closed block valves to show block valve integrity. Valves operating as shut-off valves should not allow any visual seepage of liquids across their seats over a 30 minute monitoring period.

In pressure systems containing gas, use a pressure gauge fitted to the bleed valve to monitor pressure build-up or fall off to show block valve integrity. The block valves should not allow gas to leak at a rate where a hazardous pressure build-up can develop in the downstream piping.

4.5.3 Implementing Isolation Standard 3

Before breaking containment to insert a spade, swing a spectacle blind or remove a spool piece, ensure that:

- Adequate valve isolation is in place
- Successful integrity tests have been carried out on all block valves in the isolation scheme
- The piping has been proven to be depressurised and free from hazardous fluids on both sides of the flange to be broken
- The order in which blinds are installed is high pressure lines, low pressure lines and finally Pressure Safety Valves and blowdown valves (upstream valve first).

When carrying out the isolation consider the following:

- The Permit Issuer shall consider the implications of the work on the safety of personnel and equipment involved and the impact of any other work planned in the area
- Ensure adequate Personal Protective Equipment is available and in use
- Ensure all Blinds and gaskets are rated for the line class
- Ensure all Blinds and gaskets are manufactured of material suitable for the application (e.g. acid lines etc.)
- Fit new gaskets as required
- Loosen all bolts on the far side of the flange to ensure that any stored contents/pressure will be released in a direction with least risk
- Fit all flange bolts and tighten to the specified torque in the correct sequence.

4.6 Proving Positive Isolation

Proving positive isolation is a critical part of the Permit to Work System. An Isolator shall utilise all reasonable and practical steps to ensure the job is fully de-energised and safe for work to commence.

Normal proving processes are defined above in the implementation of Isolation Standards 1 to 3. All drainage or vent points should be as close to the work area as possible. Special precautions shall be implemented when draining hydrocarbons or other hazardous material to atmosphere.

Each part of an isolation needs to be proved separately.

Each part should be proved to the highest pressure that can be expected within the system for the duration of the work activity. Some valves use pressure to activate the sealing mechanism. Care should be taken with these if there is a low pressure differential across them.

Where possible, each part of the isolation needs to be proven in the direction of the expected pressure differential.

When using pressure gauges while depressurising plant, the following points should be considered:

- Pressure gauges are reliable indicators of the existence of pressure but not of complete depressurisation. Final confirmation of zero pressure before opening shall be by checking an open vent or needle valve
- Pressure gauges will normally only give accurate indications over the middle part of the range and gauges designed to measure high pressures will often give poor response at low pressures. If pressure gauges are used to monitor or for checking isolation integrity, more than one gauge may be necessary
- Pressure gauges shall be proved before use by testing against a known pressure source.

For valve isolations, dry isolations are when isolation devices are closed without having process fluid or gas under normal operating conditions applying against the isolating device. These isolations are inherently unsafe, as the isolation point has not been proven to be effective and if pressured, may fail. To prove isolation, process fluid or gas (air or nitrogen) must be introduced against the closed isolation device and witnessing that no fluid/gas passes the drain/vent valve.

Pipes that are prone to scale build up can sometimes be blocked completely trapping substantial amounts of process fluid downstream of the isolation point and upstream of the drain point. If this is the case and if the scale breaks during the period of work, process fluid can make its way into the work area. To prove that a pipe is clear between the isolation point and the drain point, fluid should be introduced between the isolation point and the place of work ensuring that the fluid exits the system at the drainage point. This process is especially important when isolating vertical pipes and pipes prone to excessive scaling.

A vacuum can be present in pipe work and vessels that do not have a vent to atmosphere while draining liquid to grade. In this case the liquid will not drain until the vacuum is broken. Vacuums are broken by venting the pipe or vessel to atmosphere or by using a vacuum breaker.

4.7 Long Term Isolations

Long Term Isolations are required when isolations must be left in place and the Work Permit to which they apply is closed.

Where isolation schemes are to be classified as long term, consideration should be given to upgrading the isolation measures involved eg. fitting blinds or inserting spades.

The applicable Isolation Certificate with the Work Permit is registered and filed by the Permit Issuer in a Long Term Isolation record system located in the Permit Office. Reasons for maintaining such an isolation are also noted.

Long Term isolations implemented for operational reasons require the authorisation of the Area Production Superintendent or equivalent.

All Work Permits and Certificates raised to ultimately continue work require the issue of a new Isolation Certificate.

Long Term Isolations are removed following the Permit Issuer's approval and following the standard Permit to Work process for removing isolations.

4.8 Process De-isolation

De-isolation of plant containment shall only take place under the Permit to Work System with all work approved and conducted by a competent person. Recommissioning of plant shall be carried out according to document controlled operating procedures.

A thorough inspection of the equipment is required before de-isolation commences. This inspection should include:

- Checking the work site to confirm that the work is complete, the work area has been cleaned up and the equipment is safe and ready for de-isolation
- Obtaining confirmation from the Permit Issuer that de-isolation can proceed
- Checking for conflicting work in adjacent areas
- Checking the Isolation Certificate to ensure that all isolation point tags and locks are removed as part the de-isolation process.

Carry out the following procedures when removing Spades / Spectacle Blinds:

- Ensure all utility connections are closed and temporary hoses removed from the isolated equipment
- Ensure all atmospheric connections are closed (e.g. drains and vents)
- Determine if any gas or liquid under pressure is trapped behind the Blinds before removal and bleed down any gas or liquid pressure, if present
- Remove all Blinds, following the Blinds removal priority listed below
- Loosen all bolts on the far side of the flange to ensure that any stored contents/pressure will be released in a direction with least risk
- Fit new bolts where necessary especially on joints which have been 'flogged' or machine tightened
- Ensure all flange bolts are in place and tightened in the correct sequence and to the correct torque
- Conduct a thorough check for open bleed valves, vents or missing plugs and disconnected lines (walk the lines). Blank off or plug bleed and vent valves as necessary.

The sequence for blind removal is Pressure Safety Valves and Blowdown valves (downstream valve first), low-pressure lines followed by high-pressure lines.

Before equipment is leak tested or pressurised, pressure protection devices must be recommissioned. For Pressure Safety Valves (PSV's) this involves:

- Confirmation that the correct PSV has been installed and the PSV set-point has been checked
- Opening the downstream valve (discharge side) first, due to the lower flange rating, followed by the upstream valve (process side).

Recommission all shutdown and protection equipment as required including:

- Fire and emergency shutdown systems
- High and low pressure/temperature shutdowns or detection sensors
- High and low level switches.

5 APPENDICES

Appendix A	Isolation Selection Tool
Appendix B	Isolation Devices
Appendix C	Special Precautions

APPENDIX A

Isolation Selection Tool

GENERAL

This tool is based on Quantitative Risk Assessment techniques and is designed to assist the selection of an appropriate method of isolation of process plant using recognisable, readily available parameters that are relevant to the hazard. The tool should be used along with common sense, technical judgement and experience, especially when the tool provides a result that is close to a boundary between isolation methods.

PARAMETERS

1. **Effect Matrix**

- Type of fluid (in terms of its flammability, toxicity or other hazardous properties, e.g. high/low temperatures, corrosion potential, etc.). See Table 2.
- Situation (determining the potential for casualties, escalation or damage if there is a release of energy). See Table 1.

These two parameters combined give an indication of the type of effect that might arise if the isolation fails. (See Table 3 – Effects Matrix)

Table 1: Situation Parameter

Type	Description	Example
A	Congested or confined equipment or >20 people at risk. High potential for escalation.	Major Process Unit, Village within range of toxic effects, Shutdown periods
B	Open process storage or product transfer plant or 11 to 20 people at risk. Large fires with the potential for local damage.	LPG facilities, flammable liquid loading gantries, acid/NH3 loading
C	Storage area or 6 to 10 people at risk	Tankage area/farm. Unprotected control Rooms or outside workers within range of toxic effects
D	Few items of equipment in an open area or 3 to 5 people at risk	Isolated pumping area
E	Remote single items or 1 or 2 people at risk	Remote pump or vessel

Note: The number of people at risk includes those not just in the immediate vicinity, but those who could potentially be exposed to the hazard in the event of an uncontrolled release of energy.

Table 2: Substance Parameter

Type	Description
1	Toxic gases and liquids
2	LPG or flammables above a temperature where more than about 50% weight would flash on release. Material above auto ignition temperature
3	Flammable liquids above their flash point
4	Flammable gases
5	Flammable liquids below their flash point
6	Other hazardous fluids, steam, cryogenic fluids, corrosives, acids, asphyxiants, etc.
7	Non- hazardous substances

Table 3: Effects Matrix

	Situation A	Situation B	Situation C	Situation D	Situation E
Substance 1	10	10	9	8	7
Substance 2	9	8	5	4	3
Substance 3	8	6	4	3	2
Substance 4	5	4	3	2	1
Substance 5	4	3	2	1	1
Substance 6	3	2	1	1	1
Substance 7	1	1	1	1	1

Notes:

- *Vapour cloud explosions in congested or confined areas or jet fires may have the potential for knock on effects. Toxic releases may affect people over a wide area. If escalation is likely, consider increasing the severity of the situation type to a higher category*
- *In the case of a product containing more than one substance, use the most onerous substance type in the matrix*

2. Release Matrix

- Line size and system pressure (these parameters will largely fix the potential release rate and therefore the extent of the area that could be affected)

These two parameters give a measure of the size of effect and they provide a 'release' factor from the Release Matrix (see Table 4.)

Table 4: Release Matrix

		System Pressure				
		> 10000 KPa	> 5000 KPa	> 2000 KPa	> 1000 KPa	≤ 1000 KPa
Line Size	≥ 200mm	10	8	6	5	4
	150mm	8	6	5	4	3
	100mm	6	4	3	3	2
	50mm	4	3	2	2	1
	≤ 25mm	3	2	2	1	1

3. Time Matrix

- Frequency of isolation procedure
- Duration for which isolation is to remain in place

A frequent isolation for relatively long periods needs to be of a relatively high rating than an infrequent one, which is to be in place for only a short time. These two parameters provide a 'time' factor from the time matrix (see Table 5.).

Table 5: Time Matrix

		Duration		
		> 7 days	> 1 Shift	< 1 Shift
Frequency	Daily	-	10	10
	Weekly	-	10	7
	Monthly	10	7	3
	Annually	7	3	2
	Occasionally	3	2	1

Note: More frequent isolation introduces a greater risk that is also increased as the intended duration increases. It is more difficult to maintain procedural controls due to handovers at shift change between different groups of workers.

In determining the frequency of isolation, account needs to be taken of the **'group effect'** of a number of items of similar duty on a plant e.g. a pump might typically require a seal change once every 12 months and therefore the frequency of isolation in the 'time matrix' is annual. However, if four such pumps were installed, the frequency of isolation would have to be increased to 'monthly'. (Note: that quarterly does not exist in the matrix.)

Similarly the frequency of isolation must take into account the **'multiple effect'** where a number of isolations are needed to isolate an item of plant, e.g. to isolate a section of line/equipment might require a single isolation from the energy source. If this happened every three years, the frequency would be 'occasional'. However, if the line/equipment required three isolations to isolate (e.g. for a pump, from three separate suction lines from three feed tanks) the frequency would be increased to 'annually'.

4. Hazard Factor

Combining the contributions of the three factors derives the Hazard Factor for isolation:

Hazard Factor = Effects x Release x Time

The resulting Hazard Factor is a number in a range between 1 (trivial consequence) and 500+ (disastrous consequence).

5. Selection of Isolation Standard

There are three Mechanical Isolation Standards:

- **Standard 1**: Single valve and bleed
- **Standard 2**: Double block and bleed
- **Standard 3**: Physical disconnection or spool removal and fitting of blank flanges, or insertion of spades or spectacle blinds.

The particular isolation method is selected by using the following Table 6.

Table 6: Isolation Standard Selection

Hazard Factor	Isolation Standard
≤ 130	Standard 1
131 to 500	Standard 2
> 500	Standard 3

Notes:

- *In all cases, the seal integrity of each isolating valve for Standards 2 and 3 must be confirmed prior to issue of a Work Permit.*
- *Bleeds and vents should be closed once it is confirmed that the energies have been controlled.*

APPENDIX B

Isolation Devices

1. VALVES

Valves provide the simplest form of isolation device. Their advantages are:

- They are already installed
- They are quick to use
- Isolations can be easily removed to reinstate plant

The disadvantages of using valves include the following:

- They may not provide a tight shut-off due to seal damage
- Positive indication of complete isolation is not always available
- They must be locked off to prevent inadvertent operation
- They may not be in the optimum position, resulting in large inventories beyond the isolation

Only use gate, knife, plug, globe or ball valves which provide a reliable, positive, tight shut-off seal for isolations of hazardous substances

Modulating control valves and butterfly valves are only suitable for non-hazardous systems as they may not always provide a tight shut-off. (Note: Pneumatically operated butterfly valves should be mechanically locked in the isolated position)

Manual actuation is preferred with a lockable closed position and position indication

Pneumatically actuated valves (not including modulating control valves) can be used for primary isolation purposes if their fail-safe position matches their isolation function. When used as an isolation valve, the instrument air supply shall be isolated and de-pressured to atmosphere

When a power-actuated valve is to be used as part of isolation, the actuating mechanism power supply shall be isolated and disabled for the duration of the isolation

Blowdown (fail open) valves require a reliable energy source to provide closure and should be mechanically locked in the isolated position. Their use must be carefully considered as part of the risk assessment

Pressure safety valves, check valves or non return valves, including latch swing check valves shall not be used as primary isolation

Double wedge gate, parallel expanding gate or double seal ball valves, which provide a double seal in a single valve body with a bleed in between, can be used. However care should be taken in their application. Such valves should only be used in preference to a double block and bleed isolation method after increased risks have been considered in the risk assessment

Metal seat valves are more reliable than plastic or elastomer but have a higher minimum leakage rate. Elastomeric valves or seats have a lower leakage rate when new but are not as reliable

2. SPADES AND SPECTACLE BLINDS

Spades and spectacle blinds provide a mechanically simple means of physically isolating plant. The advantages are:

- Simplicity
- Low cost
- Positive indication of presence
- Positive isolation.

The disadvantages are:

- Relatively slow to install and require valve isolation for insertion and removal. Such isolations may also be remote from the work site, making control/monitoring more difficult
- They may be in a non-optimum position
- Care is needed when installing and removing them as pressure can build up behind them.

They shall be of adequate design and manufacture. They shall be clearly marked as to size and material together with the class rating for which they are suitable.

A simple system shall be used to differentiate between slip-rings and spades. A normal standard is for slip rings to have two holes and a spade to have one in the tail or tag. The pipe class rating is also marked on the tail and the tail shall be clearly visible to process/maintenance personnel.

They shall be checked before use to ensure they are suitable for the isolation and in good condition.

Gaskets used shall be in good condition and correctly rated for the particular service.

When not in use they should be maintained in a controlled storage system.

While spades selected to perform positive isolation roles must be line rated, they may be installed for other purposes. Spades or covers may be used on occasions where the only requirement is to provide barriers between compartments at ambient pressure to prevent air movement within a system that has already been shutdown and isolated. Spades / covers may only be considered for use in such close fitting situations if:

- The system extremities are isolated from all possible sources by line rated blinds
- All purge connections and hoses are dismantled
- The nature, location and use of the spade or cover are clearly noted on the Isolation Certificate and P&ID and these are identified within the relevant procedure.

3. BLANK FLANGE

Blank flanges are used when some of the plant is physically disconnected as part of the work to be done or as part of the isolation. The advantages are:

- Simplicity
- Low cost
- Clear indication of presence
- Positive isolation
- Clear indication of even minor failure.

The disadvantages are:

- Care is needed when installing and removing them as pressure can build up behind them
- They are slow to install and remove.

They shall be manufactured from material consistent with the service conditions and clearly marked with the system rating. All blank flanges shall be applied within their line rating capacity.

Gaskets used shall be in good condition and correctly rated for the particular service.

4. PIPE PLUGS

Isolation using pipe plugs may be possible with a single multi-seal plug or a number of plugs combining to form an isolation scheme.

Sufficient redundancy and independence should exist within or between plugs so that failure of a part of the sealing system does not cause total loss of sealing capability.

The location of plug(s) and sealing capabilities should be monitored and care taken during plug deployment not to damage tethered control and signal lines.

Use of this type of isolation device shall be clearly defined in a risk assessment signed off by the Area Superintendent.

5. PIPE STOPPERS

Pipe stoppers are a form of low differential pressure sealing plug that can be inserted into the open end of a cut pipe. They usually comprise a circular rubber or neoprene sealing element which is compressed between metal plates to form a seal and with the facility to vent or purge through a central port.

Stoppers are primarily used in a secondary containment role and can be used along with a valve or other means of isolation on in-service pipes or pipelines with the space between the stopper and the primary system vented to atmosphere or drained. They may also be used as a temporary plug to seal open pipe ends.

Use of this type of isolation device shall be clearly defined in a risk assessment signed off by the Area Superintendent.

6. INFLATABLE BAGS

Bags are normally used singly or in pairs, along with other pipe isolation systems. They are low differential pressure isolation systems and are commonly used to isolate low-pressure gas lines. Bags usually comprise a bladder made of rubber with an outer layer of fabric or nylon and a hose with a valve used during bag inflation or deflation.

The advantage of bags is that they can be inserted through relatively small holes cut into the pipe wall and then inflated with nitrogen or air to form a seal. Inflation needs to be enough to prevent sliding along the pipe, but must not be over done.

They should be secured to prevent being ‘lost’ in the system.

The use of bags requires constant monitoring as they are prone to sudden deflation and may be damaged during installation. A pressure gauge should be used to monitor bag inflation.

Bags should be inspected and inflation tested prior to use.

Use of this type of isolation device shall be clearly defined in a risk assessment signed off by the Area Superintendent.

7. HOT TAPPING AND STOPPLING

This is a technique for plugging a pipe that is still subject to service pressure. It is used to isolate a section of pipe and may allow continued operation by diverting the fluid through a temporary bypass. Pipe with a wide range of diameters can be isolated with this technique.

This method is only to be applied by specialist contractors with a proven track record in the particular application required and only used after a comprehensive risk assessment.

APPENDIX C

Special Precautions

1. STORED ENERGY

Isolated plant and equipment may still contain stored energy. This energy should be removed or placed in a controlled state that will not change whilst the defined work is being carried out. This particularly applies to spring mechanisms, pneumatic and hydraulic systems. Typical situations where stored energy may be encountered are listed below:

- Hydraulic systems
- Blocked lines/vessels
- Conveyor counterweight
- Air operated valves with fail safe (open/close) spring mechanisms
- Inching mechanisms
- Gearboxes on Rake Drives
- Rotary kilns/Mills
- Winch ropes under load
- Conveyor belt reels and cable reels
- Fans that could be turned by wind/drafts.

Where it is identified that stored energy is present, the Isolation Scheme shall be developed to enable work on the equipment to be carried out safely. Hierarchy of control measures should be employed when isolating equipment with stored energy:

- Highest level is to disconnect the equipment from the energy source and release any stored energy. (eg. disconnect hydraulic fittings; isolate pneumatic lines and bleed down)
- Next level is to install a physical barrier to control against movement. (e.g. pins to stop valves moving, chains to hold counterweights, chocks to support suspended rakes)
- Next level is to isolate the energy source and confirm isolation by testing for movement. (e.g. isolate hydraulic lines to valve and test for movement by operating a toggle switch)
- The lowest level is operations controls. (e.g. monitoring levels of a tank to ensure no overflow into work area, visual check of rake movement prior to isolation to ensure no stored energy in shaft).

2. BLEEDS AND VENTS

Bleeds and vents allow the safe depressurisation of parts of the plant when it has been isolated and also enable the integrity of isolations to be checked. Inadequate provision of bleeds or vents may compromise the safety of isolation.

For process plant in hazardous areas, bleeds or vents which discharge locally should not be left open, as double valve isolation will have effectively been downgraded to a single valve isolation.

The selection, provision and design of bleeds and vents will depend on the configuration of the plant and the type of isolation to be used, but certain common points should be considered:

- Be easily accessible for checking
- Be mechanically robust

- Be of sufficient size and design to minimise the possibility of becoming blocked in service
- Bleeds used for depressurising hydrocarbons will generally lead to a disposal system that may itself be subject to variable backpressures. Having depressurised the system, some small controllable venting facility to atmosphere should be used to ensure that no pressure remains
- Vents that are connected to closed venting systems that may become pressurised, such as closed drains or flares, must be closed afterwards to maintain the isolation envelope.

3. VENTING AND FLARING

The following need to be considered when planning to vent large volumes of gas from high-pressure systems:

- Ignition by stray electrical currents or static electricity must be avoided by fitting earthing straps. All potential ignition sources need to be avoided and during periods of atmospheric electrical disturbance there should not be any venting of flammable gases
- The effect of radiant heat and liquid carry over from flares on nearby structures and buildings
- The dispersal of gas or the formation of gas clouds that may gather at ground level and low points at or near areas of habitation. They may also be carried a considerable distance from the point of venting due to wind and or other atmospheric effects
- Hydrate formation, valve freezing or embrittlement effects on steel pipe-work
- The effect of noise
- The asphyxiating effects of vented gases.

Liquids may be drained from process vessels and pipe-work. Liquids may also be pumped out of a process system or pipeline or away from a section to be worked on by using water or an inert substance. For all cases, the following need to be considered:

- The asphyxiating effects of inert gases
- Volatile vapours given off from a liquid
- Protection of reception facilities from over pressurisation or over filling
- Vacuum effects within vessels/equipment during draining
- Drainage of valve cavities, dead legs, valve pits
- Disposal of pipeline fluids, contaminated water
- Buoyancy effects if gas is used to displace liquids in pipelines
- Compression effects leading to ignition of vapours
- Blocking of drain points by debris
- Hydrostatic load on the pipeline.

4. PURGING

The content of plant or pipelines may need to be removed and the equipment purged before the installation of isolations. The purge rate needs to be controlled so that the contents are satisfactorily removed, taking special care to deal with low points and dead legs. Factors influencing the method of purge are:

- The contents of the pressure system
- The physical layout of the system or change in elevations
- The asphyxiating effects of purge gases and the need to minimise the volume of toxic or flammable liquids released to the environment
- The stratification or mixing effects between transported fluid and purge gas if the purge rate is not properly controlled.

Nitrogen may be used for removing flammable gases. A correct purging sequence is vital, i.e. flammable gas, nitrogen purge, test for any residual flammable gas, air purge with the reverse sequence on reinstatement. Vaporised heated nitrogen under pressure can be effective in purging liquid containing systems

Steam is useful when heat is needed to aid the purging, e.g. with high boiling point substances. It can also be used to scour the surface of a vessel or pipeline. However it can produce static electricity, hence appropriate earthing is necessary. Expansion and condensation effects also need to be considered

Air may be used for purging non-flammable gases, but it is not generally effective in removing all liquid from long pipelines.

5. FLUSHING

Following isolation and work preparation procedures, hazardous substances will usually have been removed from the plant. However, residues can still remain, sometimes trapped in less accessible parts of the plant, ie. in internal fittings, instruments, dead legs in pipe-work, valve body cavities, roof fittings or vents and on internal surfaces. Disturbances of these residues or ambient temperature changes may release trapped gases, and high temperatures from welding may cause chemical changes.

Water is often used to flush equipment or float out light substances from vessels. Medium or high-pressure water can be used to scour the surface of a vessel or pipeline. However water must be totally removed from vessels that operate hot (ie. above boiling point of water) in normal duty because steam can be generated during commissioning activities. Water can lead to increased risks of corrosion or chemical reactions (eg. demineralised water is required for hydrogen peroxide flushing).

Pipe-work, pipe-work supports and vessels need to be designed to bear the weight if water filled. This is particularly important for flare systems.

